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PLANNING GUIDE
SELF-HELP FLOOD FORECAST & WARNING SYSTEM
SWATARA CREEK WATERSHED, PENNA.

SUSQUEHANNA RIVER BASIN COMMISSION
NOVEMBER, 1976

A

PLANNING GUIDE FOR A SELF-HELP FLOOD FORECASTING AND WARNING PROGRAM

FOR THE

SWATARA CREEK WATERSHED

PENNSYLVANIA

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SUSQUEHANNA RIVER BASIN COMMISSION
5012 Lenker Street • Mechanicsburg, Pennsylvania 17055

rom the Office of the
Executive Director

November 1976

TO ALL CONCERNED:

Immediately following Hurricane Agnes in 1972 the Susquehanna River Basin Commission established programs that would expand the National Weather Service River Forecast Programs to areas that are not normally covered by main river forecasts. To accomplish this, the Commission chose a leadership course by providing the funding and the coordination for the establishment of pilot self-help flood warning programs. The Swatara Creek Watershed was chosen as a pilot program. Almost $15,000 in Commission funds was used for the purchase and installation of additional stream gages in the Swatara Creek and Commission staff coordinated the organization and development of the program. The U.S. Geological Survey matched this cost of installing the gages.

The National Weather Service River Forecast Center at Harrisburg also contributed much effort in the establishment of the program. They surveyed the watershed selecting new gage locations and working with others have established a system of rainfall gages throughout the watershed.

The Pennsylvania Department of Environmental Resources accepted the responsibility of funding with USGS the $3,500 annual maintenance costs of the stream gaging system.

This cooperative effort by the Commission, Federal and State agencies has resulted in a system that can be used by county and local agencies for flood warning in the Swatara Watershed. Local organizations and agencies now must insure that the system operates in times of emergency providing flood warnings for the many flood prone areas throughout the Swatara Creek Watershed.

Very truly yours,

Robert J. Bielo

Robert J. Bielo
Executive Director

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A PLANNING GUIDE FOR A SELF-HELP FLOOD FORECASTING AND WARNING PROGRAM FOR THE SWATARA CREEK WATERSHED

PART I

GENERAL INFORMATION ON THE SWATARA CREEK WATERSHED

Introduction

Swatara Creek Watershed located within the Susquehanna River Basin, has sustained significant flood damage along its waterways in the past. Because of its location, the watershed is receiving development pressures resulting in continuing construction on its flood plains and a corresponding increase in flood damage potential. No flood control projects presently exist or appear possible in the near future to reduce flood damages on either the main stem of Swatara Creek or its major tributaries.

Existing flood warning systems provide advance warning of impending flooding conditions for major river tributaries and the Susquehanna River itself. There is presently no system that provides adequate advance flood warning in the Swatara Creek Watershed.

Establishment of a local flood warning system within the Swatara Creek Watershed as outlined in this plan could provide a significant means of reducing future flood damages.

General Information

Swatara Creek Watershed includes major portions of forty-one municipalities located in Dauphin, Lebanon, Berks and Schuylkill Counties in southcentral Pennsylvania. Swatara Creek Watershed encompasses 576 square miles and Swatara Creek extends approximately 65 miles from its confluence with the Susquehanna River at Middletown Borough upstream past the Borough of Tremont in Schuylkill County (Figure 1). The upper reaches of the Swatara in Schuylkill County are relatively hilly, forested and mined areas. The lower reaches in Lebanon and Dauphin Counties are of generally rolling topography with greater concentrations of population and extensive areas of cropland with a high percentage of corn and other grains.

The large tributaries of Swatara Creek include Little Swatara Creek, Quittapahilla Creek, Spring Creek, Manada Creek and Beaver Creek.

Swatara Creek Watershed contains approximately 156,000 permanent population according to 1970 census figures.

Municipalities having the largest population within the watershed are Middletown Borough, Derry Township and Lower Paxton Township in Dauphin County; and Palmyra Borough, South Lebanon Township, Lebanon City and North Lebanon Township in Lebanon County. These municipalities have a combined population of 88,964 according to the 1970 census.

History of Flooding

A recording stream gage located at Harper Tavern, approximately 28 stream miles above the mouth of Swatara Creek, provides a record of repeated flooding since the year 1919. According to this stream gage data and other historic information, Swatara Creek flooded over its primary banks at Harper Tavern 129 times in the 42-year period between 1919 and 1960. Severe floods occurred in 1889, 1933 and 1972.

The June 1972 flood caused greater property damage than any previous flooding event. It reached a flood peak of 380.4 feet above sea level at Harper Tavern, which was 15.0 feet above top of stream bank and 6.2 feet higher than the 1933 flood level.

Municipal officials reported approximately 4,200 residential and 410 commercial and industrial structures damaged during the 1972 flood. Approximately 1,100 of the residential structures and 150 commercial and industrial structures damaged were located along the banks of Swatara Creek. A majority of the damage occurred along tributary streams, with the Quittapahilla Creek and its tributaries sustaining 60% of the total damage. Flood damage also occurred along Spring, Beaver and Manada Creeks. These June 1972 flood damage property estimates are shown by general reaches on the Swatara Creek Watershed Map (Figure 1).

Flood Hydrologic Characteristics on Swatara Creek

The hydrologic characteristics of four historic flooding events within Swatara Creek Watershed have been examined to determine possible advance warning times between time of significant rainfall accumulation and stream bankfull stage and flood stage at Harper Tavern. Only limited information is available to make these estimates of advance warning times. An examination of information available on the June 1972 flood indicates a warning time of two hours in advance for stream bank overflow at Harper Tavern, eight hours for Hummelstown and ten hours for Middletown. Flood peak stage forecasts could have been given about nine hours in advance for Harper Tavern, 14 hours for Hummelstown and 16 hours for Middletown.

The data collected as part of the local flood warning system as described in this report will permit advanced warning times for a greater length of stream and allow more accurate forecasts. The system needs to be tested to determine whether advanced flood warnings of value can be provided to upstream and other tributary flood damage centers.

Flooding of the Swatara Creek Watershed near the junction with the Susquehanna River at Middletown is very complex. Flooding can be caused by Susquehanna River flood waters backing water up Swatara Creek or a combination of flood flows in the Swatara Creek and high water flows in the Susquehanna River or from Swatara Creek alone.

Hydrologic Data Collection System Within Swatara Creek Watershed

A number of hydrologic data collection stations are currently being operated within or near the Swatara Creek Watershed. The

U. S. Geological Survey currently maintains and operates five self-recording stream gages within the watershed. These are located at: Harper Tavern, Jonestown and Hershey on Swatara Creek; on Beck Creek, a tributary of Quittapahilla Creek near Cleona Borough; and on the Quittapahilla Creek near Bellgrove. The station at Harper Tavern has been a continuously recording station since 1919, but flood records exist as far back as 1889. The station on Beck Creek has been in operation since 1963. The stations at Jonestown, Hershey and Bellgrove are new stations having been installed in December 1975.

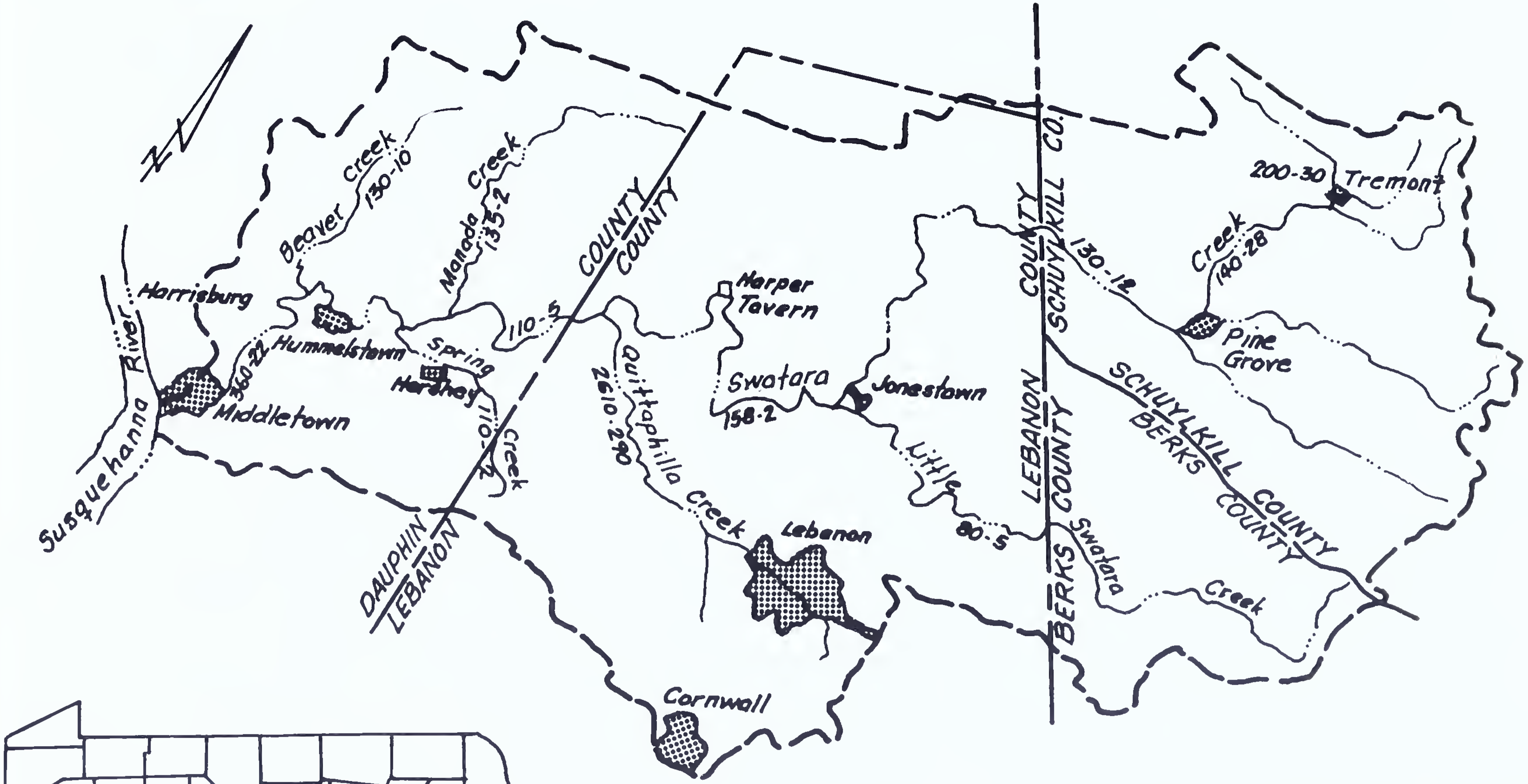
The U. S. Weather Service maintains and operates a number of rain gaging stations within or near Swatara Creek Watershed. Recording rain gages are located within the watershed at Lebanon City and just outside the watershed at Zerbe airport. Nonrecording rain gaging stations located outside the watershed, but within ten miles include: York Haven, Mt. Gretna, Myerstown, Berne, Pottsville, and Gordon.

Recent additions to the stream flow data collection system have greatly expanded the capability of flood forecasting. There are now 12 stream gaging stations in the Swatara Creek Watershed. At the present time there are: five recording gages with three back-up staff gages; two staff gages with crest staff gages; and five staff gages. See Figure 5 Swatara Creek Flood Warning Gage System.

Recent additions to the system as summarized above include the following items. A telephone recording devise has been added to the USGS gage at Harper Tavern, and a new telephone-operated gage and staff gage is installed on Swatara Creek near Hershey. A recording gage and staff gage were installed on Swatara Creek at Jonestown, and also on Quittapahilla Creek near Bellgrove. A staff and crest stage gage was installed on Little Swatara Creek near Jonestown, and a staff gage with planned addition later of a crest stage gage on Swatara Creek on Highway 645 at Pine Grove. New installed staff gages on Swatara Creek are at: 1) Spittler Road at Ravine, 2) Highway 443 at Pine Grove, 3) Highway 895 at Pine Grove, 4) Highway 645 at Pine Grove near Annville, and 5) Highway 230 at Middletown.

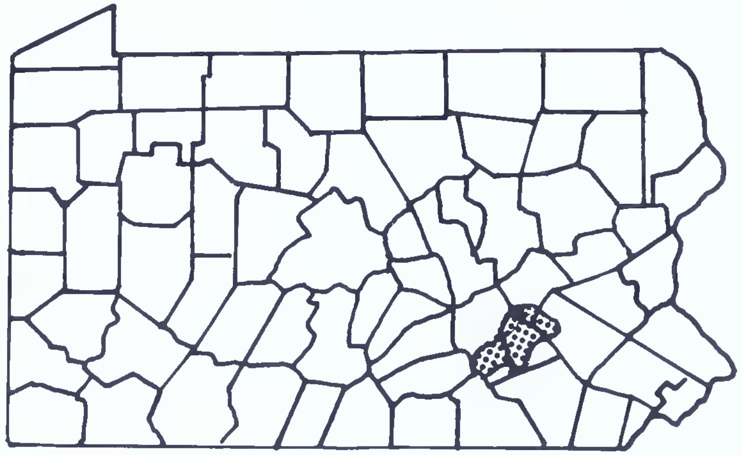
The new additions to the stream gaging system have been provided by $14,900 from the Susquehanna River Basin Commission for purchase and installation of the new equipment; the U.S. Geological Survey in cooperation with the National Weather Service selected the sites; and the USGS and the Pennsylvania Department of Environmental Resources will share the $3,500 annual operation and maintenance cost of the gaging stations. Rating tables which relate the amount of water flowing, inc cubic feet per second, to the depth of the water will be developed at all gages.

The National Weather Service has placed additional rain gages in other locations throughout the Swatara Creek Watershed as planning for the self-help warning system has progressed.



SWATARA CREEK WATERSHED

Number of Houses and Business Structures damaged by Streams within the Swatara Creek Watershed, June 1972. (Houses-Businesses)



LOCATION MAP

PART II

INFORMATION NEEDED FOR FLOOD FORECASTING

The following types of information are used in the self-help flood forecasting and warning program, for each storm or flood situation:

1) Precipitation (rainfall, snowfall, sleet, etc.)
    a) Total amount during a storm
    b) Intensity or rate of accumulation
    c) Snow cover and the rate of melting
2) Precipitation runoff
3) Stream flow as measured at stream gages
4) Time of travel of flood crests

All of this information must be combined to develop a flood forecasting procedure, and must be available during flood occurrences in order to provide flood warnings. Most watersheds have such a variable pattern of rainfall during a flood that only estimations of actual stream flows are possible. Collection of data over many years will permit more accurate predictions.

Precipitation Considerations

Several factors are considered in evaluating the effects of precipitation in each storm. These include: the form of the precipitation such as rain, snow or sleet. Also considered is the intensity or the rate of the precipitation, for example, one inch of rain in six hours, or two inches of rain in 24 hours. Total rainfall or precipitation in the storm is also considered.

Runoff Estimations

The amount and rate of precipitation runoff determines flood conditions for a particular area. The size of the watershed as well as the shape, steepness, and type of vegetation influence the rate of runoff. Studies over many years including rainfall and runoff history make it possible to estimate the runoff under varying storm conditions.

Final Index

The National Weather Service Flood Forecasting Center at Harrisburg monitors many factors which are used to estimate the amount of rainfall that is infiltrating or soaking into the soil and the amount that runs off. They will provide a continuously available Final Index. This Final Index can then be used by local officials to interpret observed rainfall in the watershed and then estimate the amount of runoff and stream levels.

Stream Gages

Gages are placed at several locations in a watershed. These gages are usually placed along the major tributary streams, often above and below the junction of two streams, in major flood prone areas, and in areas that will increase understanding of the water movement of the entire stream system.

A series of stream gages up and down a river provide a linking record of what happens during a particular storm. By using several gages, the relationship between recorded rainfall and the runoff amounts for each tributary or segment of the stream can be established. Careful observation of how rapidly the stream increases its flow or stage height with a given amount of rainfall is used to make future flood stage predictions.

Measurement of the rate of flow by the gage as related to the depth of water provides information necessary to develop a rating table or graph for the gaged site. This rating table shows the amount of water flowing past the station for a given depth of flow. For example: a stage height of 9.5 feet might correspond to a flow of 75 cubic feet per second (cfs). Then the estimated amount of precipitation above a stream gage and the Final Index can be used to estimate flow rate, and the rating can be used to determine the corresponding river stage. Since stage is expressed in feet above a sea level elevation or datum, the datum which is known, can be used with the forecast stage to provide an estimated peak flood elevation.

Flood Stage Time of Travel Consideration

Observations of several stream gages along a stream or watershed provide a means of estimating how long it will take for a flood crest or maximum flood level to travel down the stream. This is usually complicated by the fact that no two storms are exactly alike. A particular tributary may receive more rain or may have more rapid runoff with respect to the rest of the watershed, in different storms. Therefore, records are maintained over a period of years. From this recorded history, increasingly accurate predictions can be made for the time of travel of the flood stage.

Putting It All Together

Assembling all of the information on rainfall duration and intensity, rainfall runoff conditions, stream gage measurements and flood crest time of travel provides the basis for the self-help flood forecasting and warning program. This data is assembled into tables which will make it possible for an organized flood forecasting and warning system to operate. The National Weather Service has prepared these tables for use by local officials and the Swatara Flood Warning Coordinator.

PART III

ORGANIZATION OF THE SWATARA SELF-HELP FLOOD FORECASTING AND WARNING PROGRAM

An Outline of the System

The Swatara Watershed Self-Help Flood Warning System, to be successful must have the following attributes:

1) It will require a coordinator who is a full-time, paid staff member of some governmental unit, (Civil Defense Staff are in the best position to assume this role).

2) It will require inter-municipal and inter-county co-operation to be effective.

3) It will require cooperation of all of the existing emergency radio systems.

4) Volunteer stream gage and rainfall observers need to be recruited and trained.

5) The National Weather Service should alert the coordinator to possible heavy rainfall. The coordinator in turn should alert rainfall observers to monitor rainfall closely.

6) A pre-arranged system is needed for rainfall and stream gage observers to alert the coordinator. Stream gage observers should notify the coordinator when stream levels reach a specified height and then provide fre-

quent readings until after the flood crest has passed. Rainfall observers should notify the coordinator whenever rainfall exceeds a specified amount or heavy rainfall occurs in a short period of time.

7) Establish an information analysis system so that the coordinator has a basis for making an individual evaluation regarding an impending flood.

8) Establish and maintain a record-keeping system. This system should record rainfall and stream gage readings during each storm and be compiled for use in future improvements to the flood warning system.

9) An alerting system should be established which provides methods for the coordinator to communicate to pre-arranged locations; flash flood watches, flash flood warnings, flood crest predictions, and evacuation warnings. Emergency communications systems need to be established and tested. Emergency back-up communications systems need to be arranged for key volunteer observer stations so that conditions can be continually monitored during a storm.

10) Detailed mapping of flood prone areas provided by the Susquehanna River Basin Commission for the Federal Flood Insurance Program should be used to identify areas that have high flood susceptibility, and should be used as

a basis for emergency evacuation efforts.

11) Emergency action efforts organized to respond to the flood warning program should include stream and road patrols, and a evacuation plan. The evacuation plan should be developed for all flood prone areas. It should be tested and used when needed.

Organization of a Flood Alert System

There is a need for cooperation in developing the flood alert and warning system. This will require an inventory of existing organizations and communications facilities. Determinations must be made of the priority and supervisory relationship at every level of operation.

Organizational efforts should be carried out at the county level with separate initial organizational meetings held in Schuylkill, Lebanon and Dauphin Counties. Those portions of Berks County that are in the watershed should be invited to participate in one of the other county meetings.

County Inventory of Organizations

Inventory of all organizations in each county that have a public service or public safety responsibility. The list shown in Figure 2 may not include all of the organizations in your county. Add to the list where appropriate.

Completion of this inventory listing will probably produce surprises at the resources that are available within a county. After identifying these resources the next step will be to create a workable method of using these resources; of putting them together into an effective action organization. To be most effective there should be a plan to use each of the resources that are available in a manner which is acceptable to those involved, but complementary to other activities. This will require cooperation and coordination. The surest way of obtaining this cooperation will be to include each of the organizations identified in the development of the plan.

Initial County Organizational Meeting

A completed inventory of organizations provides a listing of candidates who should be invited to participate in the initial county organizational meeting.

It is important to get off on the right foot at this organizational meeting. Establishing a climate of cooperation at this time will result later in more effective coordination and more support for the system. The following steps are suggested in planning and organizing this meeting:

1) Call or visit each leader identified on the organizational inventory. Explain the purpose of the flood warning program. Ask each person if they would attend a meeting or send an alternate. Ask him what is

a good time for a meeting. Let him know that you will inform him soon when and where the meeting will be held.

2) After contacting each leader, choose a date and place for the meeting. Select a date allowing plenty of advance notice to enhance attendance (at least two weeks).

3) Mail a meeting notice which includes date, time and place of meeting. Also include a copy of the Flood Alert Organizational Assessment (See Figure 3) and an outline or list of tasks essential for establishing a local flood forecast and warning system (Part IV).

4) Two days before the meeting, recontact each person and remind them of the meeting and inform them about meeting plans.

Conducting the Meeting

Each of the leaders should have received in the mail, the Flood Alert Organizational Inventory and the List of Flood Forecasting and Warning Tasks. These should form the basis of the meeting. The following is a suggested Agenda for this meeting.

Tentative Agenda:

1) Introduction of attendees.

2) Explain the basic purposes of the meeting and the basics of a flood forecasting and warning program.

3) Review the List of Flood Forecasting and Warning Tasks.

4) Ask each leader to identify which tasks are most appropriate to his organization and to fill out the Flood Alert Organizational Assessment Sheet, Figure 3.

5) Using a blackboard or easel, identify which organizations will be doing which tasks so that all can see the overall need.

6) Identify voids or possible areas where additional assistance and manpower will be needed.

7) Organizations and leadership is normally provided by County Civil Defense Offices because of their responsibilities in natural disaster coordination. It may be necessary to select and train a coordinator who is responsible to one or more Civil Defense Offices.

8) Follow-up efforts should be discussed and a date selected for the next meeting.

Each organization should select the particular part of the flood warning system which they can do best. Unfilled tasks which were not designated and other voids should be filled in later by follow-up efforts by the coordinator.

Some of the tasks will require more effort and manpower than others, so if there are two organizations who feel that they can perform a single task then a sharing of responsibilities should be arranged but with a clear understanding of who is to do what. If there is disagreement about who should be responsible for a particular task, then it would be best to have a separate meeting with each party to work out the differences and come to a workable arrangement. If agreement cannot be reached, then the program coordinator should assign tasks to the organization who is judged the best to perform the job.

As the meeting progresses, individual assignments should begin to be made. Suggested names of individual volunteers should be recorded for later follow-up, reminding the group that this is a tentative list and that nothing will be finalized until the whole system is re-evaluated at a later meeting.

PART IV

LIST OF FLOOD FORECASTING AND WARNING TASKS

This section describes the tasks or jobs which need to be assumed by different organizations in order for the Swatara Self-Help Flood Forecasting and Warning Program to operate successfully and accomplish what it is designed for -- to reduce the threat to the general public of unanticipated flooding and flood damage, if and when flooding occurs.

Coordination

The key person in the operation of the flood warning system during an emergency is the coordinator. For that reason this person should be a full-time employe of a governmental unit. In larger communities and counties, this person would normally be the Civil Defense Director. Where there is no civil position, then another full-time governmental employe should be given the responsibility. In either case, approval by local government-elected officials is needed.

The Civil Defense Director may wish to delegate someone to act as the coordinator for the program but should still assume overall responsibility and authority for the operation of the program.

There should be two back-up individuals who are trained to operate the system in case the coordinator is not available, is sick, etc. There should be an assigned order of succession of the back-up personnel so that each knows when they are responsible to assume control.

Specific tasks of the Coordinator or back-up person are:

1) Issue instructions to stream gage and rainfall observers. Collect rainfall and stream level reports from observers.

2) Use previously prepared reports by the U.S. Geological Survey, National Weather Service and Susquehanna River Basin Commission to determine flood risks based on assembled data from observers.

3) Determine severity of situation and appropriate responsive action such as crest predictions and evacuation warnings.

4) Issue flash flood warnings, flood predictions, and evacuation messages based on guidelines and assembled information from observers.

5) Maintain contact with National Weather Service for additional information about the situation. Obtain a current final index from National Weather Service River Forecast Center, Harrisburg.

6) Make initial contact and follow-up reports to the National Weather Service on local situations.

7) Assume responsibility for selection, replacement and training of all observers.

8) Organize an emergency communications center. It should serve as the heart of the system. The center serves as the critical focal point of information assembly, evaluation and warning dissemination.

9) Activate emergency communications and operations center when situation indicates high water or flooding is possible.

10) Operate trial runs of the system. Evaluate the system and make adjustments following evaluation.

11) Maintain interest in the program through publicity, recognition to volunteer observers, and other public information programs.

12) Maintain a log of rainfall and stream observations for each storm. Distribute reports to interested parties including the National Weather Service and the U. S. Geological Survey.

13) Organize, maintain and supervise a back-up emergency radio communications system through which rainfall and stream observations can be obtained when telephones become inoperable.

Stream Gage Observers

Stream staff gages and crest gages will be or are placed in various locations in the Swatara Creek and its tributary streams. Two of these gages can be read through a telephone reporting system. Information can be obtained from these gages without personal observation; however, a personal observation system should be planned in case of telephone failure during an emergency. Volunteers are needed who will personally observe and report to the coordinator as a storm progresses in order for the coordinator to make determinations about flood conditions. Back-up communications via radio transmitter will be required to link the observers to the coordination center in the event of ground communication system problems due to storm damage.

Rainfall Observers

Rainfall information is needed to supplement information obtained from stream gages. This is especially true of tributary streams or upper reaches of the watershed. In these locations, observations of rapid changes in water levels at stream locations would be too late to provide adequate flood warning for many areas. Therefore, rainfall observers should be organized at selected locations around the watershed where additional information would greatly increase the flood forecasting capability of the program. These observers need to be linked to the coordination center by telephone and/or radio.

Selection of Observers

The following is a suggested guideline to be used in selecting volunteer stream gage and rainfall observers:

1) Live or work near a stream gage or in an area where rainfall information is needed.

2) Home is not located in a floodway or flood fringe area. The reason for this is that the person selected should not be in a conflicting situation wherein their personal safety or property are in jeopardy while simultaneously having the responsibility to read a stream or rain gage during a flood.

3) The person is motivated and responsible enough to help others; will do the job over a long period of time, several years; and will attend training sessions and stick to the job during a crisis.

4) There must be access to a telephone 24-hours-a-day. A private telephone line which has a trouble-free record during inclement weather is preferred.

5) All rainfall and stream observers should have access to radio communications in case phones become inoperable. Mobile radio should be used at most stream gages.

6) Stream gage observers should have a binocular and a flashlight or spotlight to read stream gages at night and from a remote location.

7) Consideration should be given to having a few rainfall and stream gage observations made at locations where someone is on duty 24-hours-a-day. Locations such as police stations, hospitals, and other locations where someone is present 24-hours-a-day may provide opportunity for early warning during a storm.

8) Later as a storm develops observers should not have other emergency responsibilities. In any case one or more persons should assume back-up responsibilities to make observations.

Analyzing -- Decision Making

A self-help flood forecasting and warning program will not work unless there is adequate information, a method of analysis, a system of making decisions, and dissemination of information. The analysis and decision-making role should be carried out by the coordinator of the system. There should be two back-up persons who are capable of doing the job in case of vacations, sickness, etc., as mentioned previously. The following tasks are essential in the analyzing and decision-making role.

1) Attain a personal knowledge of the watershed, including its geographic and hydrologic peculiarities.

2) Attain a personal acquaintance with observers and other volunteers involved in the program. This personal knowl-

edge will enable a more effective understanding of the capabilities of the individuals and the system to operate in an emergency.

3) Understand how the information gathering system operates; who is to do what and what alternative methods there are during a crisis.

4) Know what decisions need to be made based on assembled information and be capable of making them. The following are the kinds of decisions that need to be made:

   a) Receive warning of potential heavy rain or possible flood problems. This could be either received from rainfall reporters, stream gage reports or an alert from the National Weather Service. During this phase, individually contact all rainfall and stream gage observers and instruct them to observe and report situation at pre-determined intervals.

   b) Evaluate all information and determine the state of potential flood problems.

   c) Relay flash flood watches and warnings issued by the National Weather Service. Special attention should be made to upstream or headwater areas with a history of flood problems. (Tremont, Pine Grove, and Lebanon)

d) As storm or flood progresses, determine flood crest situation and make initial estimates of the time and height of flood crest.

e) Continual re-evaluation to determine path of storm and potentials for flood conditions. Make appropriate warning announcements.

f) Issue flood crest predictions.

g) Issue evacuation announcement based on evacuation study and plan.

h) As a flood develops, issue periodic reports to appropriate National Weather Service offices and other agencies and public officials.

Emergency Operations and Communications Center

An emergency operations and communications center is the key to coordination of efforts. The center brings together the necessary information, leadership and authority that will result in the most effective decisions and action.

Procedures for the activation of the center need to be carefully developed. These procedures should explain in detail at what time and by who the center is opened. There should be a designation of who is to work at the center, and who is to provide back-up to these individuals. There are three emergency operations centers that can serve the Swatara Watershed. These are the communications centers at Lebanon and Harrisburg, and the emergency operations center at Pottsville.

An outline of procedures follows which could be used in operating these centers during a flood threat. (Figure 4)

This outline of a procedure is not a plan for operating the Emergency Operations Center. A more-detailed plan is needed that describes who and what will be done and at what time. Not all of the phases of the plan may be needed. Some steps may be skipped if unusual situations develop. However, every possible situation should be investigated and an attempt made to describe how it will be handled.

FIGURE 4

OUTLINE OF OPERATIONAL PROCEDURES FOR A LOCAL EMERGENCY OPERATIONS/COMMUNICATIONS CENTER

Phases	Personnel	Action
Flash Flood Watch from NWS or heavy rain reported by observers	Coordinator and back-up	- Remain near phone - Obtain forecast from NWS, get latest final index - Alert all rainfall observers to possibility of heavy rainfall and to report when rain exceeds a predetermined amount
Flash Flood Watch with continued local heavy rain	Coordinator and back-up	- Go to EOC - Call and assemble first key EOC staff - Alert stream observers - Contact community directors - Start stream and highway patrol
Flash Flood Warning local flooding occurring	EOC partially staffed	- Assemble full EOC staff - Order alert for communications systems - Begin hourly plotting of rainfall and stream data - Alert key staff of other agencies of possible problems
Main Stream flood levels expected	EOC fully staffed	- Order full activation of county and community emergency efforts - Activate back-up radio to rain and stream observers - Establish inter-count radio communications - Contact NWS office - Obtain latest weather forecast. Report rainfall data and discuss expected flood levels.

FIGURE 4 (Cont'd)

Phases	Personnel	Action
Flood Warning (Streams rising, peak not reached)	EOC fully staffed county and community staff fully activated	- Update rainfall evaluation - Review situation with NWS-Jointly select flood stage prediction and statement - Issue flood stage prediction for Harper Tavern. - Order stand-by evacuation plan for upstream flood prone areas.
Flood Condition (Up stream flood peaks reached)	EOC, County and Community emergency units fully operational	- Revise flood prediction and public statement if needed. - Make flood level prediction for Hershey and Middletown. - Issue evacuation orders - Coordinate with area Civil Defense. - Estimate outside assistance needed
Flooding Continues (Crest moving downstream)	EOC, County and community emergency units fully operational	- Revised flood crest predictions for Hershey and Middletown if needed - Continue evaluation of evacuation needs.

Stream and Highway Patrol

Upon receipt of a flash flood watch, a stream and highway patrol should be alerted. If heavy rains begin or are reported, patrols should survey the streams and highways in the area to watch for local flooding conditions, blockages of stream channels from mud slides, trees and other obstructions. Special attention should be given to all bridges and culverts. All roads should be patrolled to identify local flood situations and to monitor road access to low-lying areas subject to flooding. Any unusual or dangerous conditions should be reported back to local officials who can base decisions on this information and to notify the coordinator of the situation. Adequate manpower should be planned for to carry-out these patrols in a short period of time.

Public Information

There are two types of public information which should be used. One is an information program designed to acquaint the public with the flood warning system. The other is an information system that will be used during an emergency.

1. Information About the Flood Warning System

Information about the organization and operation of the flood warning system should be systematically disseminated to area newspapers, radio and TV. Speaking at area service clubs and organizations would further spread the word. Talks at other organizations such as watershed associations and environmental clubs may be opportunities to explain what it is all about.

Reports of activities, training meetings, trial runs would make interesting news copy. Involve local news reporters in these events and the stories will appear without much effort.

The best information following a flood would be what was done; what stream gage level readings were at the flood peak; what areas were evacuated; what damages were reduced; and what improvements and/or changes needed as a result of the experience.

2. Information to the Public During a Flood Emergency

A scheduled systematic method of communicating to the public is needed during a flood emergency. Messages should describe the nature of the storm, (type of rainfall, snowmelt, ice jams, thunderstorms, etc.) The messages should explain the meaning of terms such as flash flooding, flood peak or stage, expected travel time of the flood peak, etc.

Methods used to communicate to the public during a flood emergency will depend upon warning time, the duration of the storm, the type of flooding and extent of it downstream. During long duration storms, newspapers, radio and TV should all be used. During flash flood situations, radio and TV may be the only quick method of reaching the public. IMPORTANT -- Do not rely solely on mass communications methods during a flood emergency. Word of mouth, and emergency action in critical areas will provide the best methods of communication. If time is short, delay would increase risks and damages, therefore, rely on the established action system that has been organized.

Communication methods used during the late evening and early morning should be limited to the emergency system as planned. During flash flood situations, conditions require rapid action. There may be little time for mass communications to be effective, or they may occur at times of the day when no one is listening to radio or watching TV.

A Swatara Watershed Tri-County Stream Prediction and Warning Communication System has been organized. The communication system utilizes telephone and radio. An organizational chart of the system is shown on Figure 6.

PART V

THE ACTION-RESPONSE SYSTEM -- AN EVACUATION PLAN

The Swatara Flood Forecasting and Warning System as described in Part IV to be most effective and to provide the greatest protection of life and greatest amount of flood damage reduction must have an action system response. The flood forecasting and warning system provides the information that enables officials to make decisions. The action system response is the end product of the forecast and warning.

An evacuation plan is an organized system that assembles, trains, and establishes lines of authority with specific assignments and actions.

The evacuation plan should cover each governmental unit and municipality with potential flood problems. The plan should describe for each municipality: what is needed to be done; who is to do it; and who is responsible to see that it is done. The key to success of the entire flood warning system will be this pre-planned series of decisions and actions. No single person can do the job, however, someone must have the authority to instigate it and others must be aware of what is expected of them and be capable of carrying out the necessary action. It will be necessary to monitor how the system is operating in order to deal with unexpected problems and emergencies.

The evacuation plan should identify where decisions are made at each level of government (county, local municipality). It should designate responsibility for both organizations and individuals, including their back-up. It should designate the coordinator or person responsible at each level of government. Training programs and trial runs should be activated periodically to test the system and keep it up to date.

The following tasks should be considered:

Designate Priority of Evacuation Assistance

A survey of flood-prone areas should be carried out. This survey should identify at what flood elevation individual properties or areas become flooded. A systematic evaluation of flood-prone areas at all expected flood levels is needed. Following completion of this survey a priority designation should be given to each area. The following factors should be used in assigning a priority:

1) Which areas are flooded first?

2) What is the severity of flooding at different flood levels?

3) Is flooding from flash flooding, main stream flows, backwater, or ponding behind obstructions?

4) Will there be loss of access or egress from an area because roads are closed?

5) Are there areas where seepage, back-up water through sewage line, drainage ditches occur?

6) Will flooding make areas uninhabitable because of a loss of public utilities or other services?

Priority designations should carefully consider the amount of warning time available. In areas with several hours of advanced warning, different actions are possible and therefore different factors should be considered in establishing the priority.

Multi-phased System

There are two different flood situations which should be considered. One is flash flooding and the other is main stream flooding.

1) Flash Flooding - Flash floods occur at any time and at any place in the watershed. Intense rainfall, especially from thunderstorms can produce excessive local runoff and cause serious flood situations. Flood conditions can be reached in a short time, often minutes. Observation of local conditions is the only way to effectively provide a warning. The National Weather Service issues a flash flood watch. This warning should be used to alert the flood warning system. This Swatara Self-Help Flood Forecasting and Warning System provides guidelines for three separate flash flood warning procedures at Tremont

and Pine Grove, Lebanon and Hershey. These procedures are described in the Self-Help Forecast Notebook supplied to local officials and the coordinator. A separate locally-organized evacuation system will be the first or earliest phase of any evaucation plan. Road and stream patrols described earlier should become part of the local alerting system.

2) Main Stream Flooding - Flooding on the main stem of Swatara Creek and its major tributaries does not develop as rapidly and there may be more warning time. Therefore, multiple phases to an evacuation plan are possible. Each phase should be based on the flood levels that are expected. The following briefly outlines an example of the phases of the plan that could be used:

Phases	Flood Levels
1) Beginning flooding	Beginning flooding of low-lying areas
2) Minor flooding	Slightly over bankfull
3) Moderate flooding	Up to 5 feet above bankfull
4) Major flooding	Over 5 feet above bankfull

Flood levels have exceeded 15 feet in large areas of the Swatara Watershed. Therefore different actions will be needed as different higher flood levels are reached.

Evacuation Routes

The evacuation plan should designate evacuation routes for each area flooded. A study of each municipality's road system should identify and describe the safest possible evacuation routes. Floodprone areas and areas subject to being isolated (from early flash flooding) need to be identified. Main stream flooding is apt to cause major disruption to the road system. Careful evaluation of the affect on roads should be made at different flood levels. The following check list should assist in identifying the most appropriate evacuation route for each area:

1) Is the route high and dry? Is it passable in all weather conditions?

2) Does the road experience early flooding from local runoff?

3) Is the road a major transportation route? Will the road become clogged with traffic?

4) Are there alternate main-through roads that will relieve local traffic congestion?

5) Should some roads be closed to all but evacuation traffic?

Traffic Control

Methods of warning the public and controlling traffic will be needed throughout a flood. Stream and highway patrols should be used continuously and should identify problem areas. Methods of closing roads and bridges will be needed. Traffic control should consider the following:

1) Which roads will be closed early in the flood?

2) What alternate routes can be used, and what detours will be needed?

3) Are there ways of handling major highways to reduce traffic congestion?

4) What bridges and roads are the most floodprone? What will their closing do to the transportation system?

5) What manpower will be needed to guard dangerous areas, to direct traffic, to continue patrols, and to be constantly alert to developing situations?

6) Can a pass system or some other system of access control be used for flooded areas?

Reception Areas

Areas should be identified that can provide temporary housing, food, water, and medical care for evacuees. Reception centers should be safe, and out of floodprone areas. They should be easily identifiable and have sufficient area for people and their possessions. An operational plan should include staffing, supplies, equipment and services that will be needed.

Emergency Actions

Emergency situations will develop during a flood, but planning for the unexpected will make effective responses easier. Some of the emergency actions which should be considered are:

1) Emergency evacuation -- A rescue team, a boat, large vehicle, and other tools and equipment may be needed.

2) Emergency medical care, fire control, toxic substances control should be considered.

3) A method of searching for survivors is needed.

Damage Reduction

In upstream and tributary areas of the watershed, advance warning of flood conditions may be limited to a few minutes or an hour or two. This does not provide enough warning time to assist people to move their personal belongings. Emphasis should be placed on protection of human life in this situation.

In downstream areas, however, flood warning could be 8 to 10 hours, or longer, in some locations. In cases where there is adequate warning time there is much that could be done to reduce damages to personal property, inventories, etc. Plans should include guidelines for individuals to help themselves and for assistance whenever it can be made available.

The following tasks need to be considered:

1) Reduce overflow, seepage and erosion by sandbagging, pumping, closing flood gates and manholes and other temporary measures.

2) Stream and road patrols should be on the lookout for blockages which can cause rapid and serious flood conditions. Prompt efforts to remove debris lodged under bridges and culverts can reduce flood damage.

3) Remove records from private and public locations. Banks, libraries and other public buildings and offices should have alternate locations for records and irreplacable items.

4) Temporary movement to the second floor, or temporary relocation of household goods, clothing, automobiles, equipment and supplies of individual residents can greatly reduce damages. Use of trucks, trailers, warehouses, and barns for storage should be investigated.

5) Planning assistance for business, industry, and commerce to develop their own damage reduction and evacuation plans is needed. There are many businesses and firms located on the flood plain in the Swatara Watershed. Substantial damage reduction

is possible if each firm studies what damage can occur and how to reduce it. Special needs may be met from outside assistance in equipment, manpower, materials, etc.

6) Provide adequate manpower where it is needed and at the time it is needed to reduce flood damages. There is never enough manpower to do all of the things that are possible to reduce flood damages. However, through advanced planning additional manpower could be used at the most critical locations to assist individuals and businesses. Needs for special vehicles, equipment and tools should be identified and located prior to flood emergency. Gateways or assembly points for volunteer manpower, equipment and supplies should be designated. Radio and TV, and newspapers could be used to solicit this assistance.

Termination of Evacuation

A pre-determined time should be established when all evacuation efforts are terminated. Previous studies should indicate at what flood level it is no longer safe to continue evacuation in each area. Upstream flood levels, crest travel time, time needed to evacuate all people and equipment should be the determining factors in terminating evacuation assistance.

As you travel downstream the more chance there is for a longer flood warning and more time to carry-out an organized evacuation.

However, the further downstream the greater the chance of much higher flood levels. Protection of life should always be considered before anything else in an evacuation effort.

Protection of Flooded Properties

Flooded properties need to be protected from looting, fire and other emergencies before residents and owners are permitted to return. Sightseers and those who legitimately belong in an area are difficult to separate. Police, sheriff, state police and National Guard may be sources of assistance to protect flooded properties. A security system of controlling who is allowed into an area will be needed.

PART VI

FOLLOW-UP ORGANIZATIONAL STEPS

After holding the initial organizational meeting it will be simple to determine which organizations should assume the various tasks described earlier in the previous sections. Tasks which are not assumed or where there is insufficient manpower should be reviewed and additional assistance solicited to fill the voids.

It is assumed that County Civil Defense Directors will play a key role in organizing the flood warning program. If this is the situation then many of the organizational decisions will already have been made and only the operational details will require attention.

Several points are suggested, however, to insure that there is understanding between Federal, State and local organizations and individuals involved in the program. Federal and State agencies directly involved are: the National Weather Service River Forecast Center at Harrisburg, the United States Geological Survey at Harrisburg, the Pennsylvania Department of Environmental Resources, Pennsylvania Commonwealth and Area Civil Defense, and the Susquehanna River Basin Commission. Each of these agencies has a role and responsibility in assisting in organizing the program, and therefore should be involved in the development of the final program.

The Swatara Watershed is located in major parts of Schuylkill, Lebanon and Dauphin Counties, with a small portion of Berks County included. Floodprone areas are in Schuylkill, Lebanon and Dauphin Counties. Since these three counties have a major interest in the development of the flood forecasting and warning program, the organizational structure should reflect these interests. Therefore, it is suggested that separate organizational meetings be carried out in each of the three counties. Following these county organizational meetings, an overall coordination meeting should be held which brings together all of the interested parties at which time the overall plan is developed. All levels of involvement including Federal, State, county and local interests should be invited to participate in the overall organizational meetings. Because of its role in river basin management program development, it is suggested that the Susquehanna River Basin Commission organize and host meetings and assist in the development of the final plan.

The following factors in development of the final plan should be considered:

1) A central coordinator for the entire watershed should be selected. This person and a deputy or alternate should be on call 24-hours-a-day, 7-days a week. All pertinent data for evaluation and preduction should be located at an operating communications center where back-up radio communications are available to all areas, and where there is sufficient manpower and as-

sistance to provide multi-county coordination and communication. Because of location, Lebanon County Civil Defense Headquarters is the most likely location for the coordinator.

2) Assembly of rainfall and stream gage data could be delivered directly to the one center or channeled through the three different civil defense centers to a single center.

3) All forecasts and dispatches should go automatically to the three civil defense centers.

4) All aspects of evacuation, stream and road patrols should go through the three civil defense centers.

5) There should be close communications established with the area civil defense centers at Hamburg and Selinsgrove.

6) The Coordination Center should establish and maintain close communications with the Harrisburg River Forecasting Center.

Organizational Maintenance

A challenge to the continued effective operation of a self-help flood warning system will be the maintenance of a viable organization. Maintaining interest in and knowledge of how the system operates will not be easy. Volunteers who serve as rainfall and stream gage observers will need recognition for what they are doing.

There also will be a need to maintain close communications with other organizations who will participate in the system. Close cooperation is essential, therefore, a series of continued contacts with these organizations and their leaders will be needed. Leadership of organizations change. With changes in leadership there will be a need to make contact with new leaders to inform them of the system and to obtain their cooperation. Contacts should be maintained with Civil Defense, fire, police, and other organizations who are needed to make the system function.

A dinner meeting should be held every other year at which time recognition should be given to the observers and to the cooperating organizations. Key political leaders should be invited to participate. The agenda might include a review of the system, explanation of additions or changes in the system, a report on how the system operated during a storm, etc. An entertaining or informative speaker might highlight the program. A sponsor for the dinner meeting might be a municipality, business or manufacturing concern who stands to gain from the operation of the system. News media representatives should be invited to attend.

PART VII

FOLLOW-UP AFTER A FLOOD EVENT

The flood forecasting and warning system should be thoroughly evaluated following each flood event. Revisions should be made and tested where necessary. The following list suggests some activities which should be completed as part of the evaluation after a flood.

1) Identify highwater marks. Painting of highwater marks on bridges, utility poles and other markers can be used for later compilation of detailed flood stage damage maps. These maps show at what flood stage or elevation a particular area is flooded. The maps should be made available to all emergency organizations for use during the next flood.

2) Hold a post-mortem meeting with all the volunteers, organizations and agencies who participated in the warning system. This meeting should be a positive effort to obtain increased support from those participating in the system and recognition of the benefits attained from participation in and contribution to the warning system program. A step-by-step review should be completed of the actions taken during the flood. Evaluate what worked and what didn't work during operation of the system. Recommendations for improvements should be immediately evaluated and, if warranted, incorporated into a revised plan. Prepare a summary report for elected officials, news media, cooperating local, State and Fed-

eral agencies and organizations and concerned individuals.

3) Carry-out a simulation exercise on the revised plan to determine if it operates as intended.

4) Carry-out a damage reduction survey. Evaluate the value of structures and contents of personal property and business damages reduced and disruption alleviated through implementation of the flood forecast warning (and response) system.

PART VIII

AN EXAMPLE -- HOW THE SYSTEM OPERATES

A description of a hypothetical storm will assist you in understanding how this self-help flood forecasting and warning system operates.

A Hypothetical Storm

On October 1, a storm occurred in the Swatara Watershed. This storm was preceded by a week of rainy weather in which 1.2 inches of rain had fallen. Streams were at average levels and the ground-stored moisture levels were high.

On the afternoon and evening of October 1 and the morning of October 2, a series of thunderstorms were followed by a general rain which lasted for several hours.

On October 1st, the flood warning coordinator determined that soil moisture conditions were high. A thunderstorm occurred in the late afternoon which further alerted him to carefully monitor weather conditions. He called the Harrisburg National Weather Service Office and was informed that there could be thunderstorms throughout the night and that additional rainfall might occur the following day.

The coordinator immediately called all rainfall observers and asked them to notify the communications center immediately in case they had a heavy thunderstorm or precipitation exceeding one inch at any time following 7:00 p.m. that evening. Before leaving for home for the evening, the coordinator informed the communications center dispatcher where he would be and asked to be called whenever additional information was received from the rainfall observers.

At 11:30 p.m. a heavy thunderstorm occurred in the upper reaches of the basin. A rainfall observer found that 1.3 inches of rain had fallen since his last observation at 7:00 p.m. that evening. He immediately telephoned the communications center and the coordinator was notified. The coordinator asked the communications center to contact four additional rainfall observers in widely scattered locations in the watershed by phone and determine if there was heavy rainfall in other areas. At 12:30 a.m. the communications center returned a call notifying him that he was able to reach two of the four observers and one reported that he had measured .9 inches of rain and that a heavy thunderstorm was then occurring. The coordinator informed the communications center that he would go to his office to more carefully monitor the storm, and to have all rainfall observers that could not be reached by phone contacted by a mobile radio unit as rapidly as possible, and obtain the latest information.

The coordinator reached the communications center at 12:45 a.m. and was informed that there were reports coming in by phone and radio that heavy thunderstorms were occurring or had just passed through several areas in the watershed. The coordinator immediately issued an alert. This message was dispatched throughout the watershed to local civil defense directors. These directors were to evaluate the local situation and report back to the communications center.

At this time, the coordinator began a plot of rainfall information. In a few minutes from these calculations, he determined that there was a potential flood situation with high potential for flash flood conditions in upstream tributary areas. He called the Harrisburg Weather Service and learned that existing weather conditions would continue followed by a general rain in the next eight hours. He immediately issued a warning which activated county civil defense centers and notified radio and TV of the situation.

At 1:30 a.m. reports began to come from community civil defense directors that several tributary streams were rapidly rising and the coordinator dispatched a message that stream and road patrols should be started and evacuation of high flood hazard areas might become necessary in the next one to three hours. At the same time, all stream gage observers were alerted by phone and arrangements were made for back-up mobile radio communications at each stream gage. Radio back-up was also asked for six rainfall observers who could not be contacted by phone.

At 2:00 a.m. all three county civil defense centers and the flood forecasting center were in full operation with all back-up personnel on the scene. Information was being rapidly assembled from rainfall observers, stream gage observers and civil defense. Tremont reported that flood stage had just begun and evacuation was underway in the most critical areas. Lebanon reported that the stream was just below flood stage but rapidly rising and that the full civil defense system had been activated. Stream gage reports indicated that upstream areas were having a rapid rise in water levels, but lower reaches of the Swatara had not shown much change.

At 3:00 the coordinator re-assembled all rainfall and stream gage information. A steady but light rainfall was falling with rainfall ranging from 1.35 to 2.75 inches, with most areas receiving about 2.0 inches of rain from the preceding evening at 7:00 p.m. Upstream gages indicated a continued increase in water levels and gradual increases were occurring in downstream areas. A flood alert for the entire Swatara Watershed was released, which activated all emergency efforts and notified the news media.

By 5:30 a.m. it became apparent that moderate flood conditions were developing, upstream gages reporting that the flood crest had been reached at Pine Grove and the Upper Quittapahilla below Lebanon.

An exception was the Little Swatara Creek above Jonestown which had reached flood levels and was still rising. Rainfall observers near Jonestown had indicated that rainfall was greatest in this portion of the watershed and that rainfall was continuing.

At this time, the following flood crest predictions for the Swatara were issued:

Harper Tavern -- Predicted crest at 8:00 a.m. at 7-8 feet
Hummelstown -- Predicted crest at Noon at 5-6 feet
Middletown -- Predicted crest at 4:00 p.m. at 6-7 feet

A separate warning was issued for the Little Swatara Creek Area - Immediate - Severe flooding expected along the Little Swatara Creek and in the vicinity of Jonestown, above the confluence with Swatara Creek.

Evacuation orders were issued for all low-lying areas subject to flooding along the lower reaches of Swatara Creek. All community emergency operations efforts were in active operation with evacuation assistance and the opening of evacuation reception centers in the Middletown area.

By 8:00 a.m. rainfall observers reported that the rain had stopped. Total rainfall from the previous evening ranged from 1.8 to 3.0 inches with most areas receiving about 2.5 inches.

At 9:00 a.m. the Little Swatara had crested with severe flooding conditions. A moderate flood crest occurred at 9:15 a.m. at Harper Tavern slightly lower than expected. Moderate flood crests occurred at 1:00 p.m. at Hummelstown and 5:00 p.m. at Middletown. The storm was localized to the Swatara Watershed. The storm did not cover a large portion of the Susquehanna River Basin, therefore, there was no serious flooding from back-up waters of the Susquehanna River at Middletown.

This is a hypothetical example of a storm and how the flood forecasting and warning system in the Swatara Creek Watershed should operate. This example shows how the functions of rainfall and stream level observations utilizing an emergency communications system and civil defense warning and evacuation action could result in reductions to the risk of life and flood damages through timely evacuation.

In this example, stream patrols identified a major problem near Pine Grove where a tree had become lodged under a bridge and quick evacuation of several homes was needed. Other people who resided in the Middletown area were evacuated, but since the water had not reached high flood levels, homes and properties in this area were not seriously flooded.

Overall, such a flood forecasting and warning system has much potential for the reduction of risks and decrease in flood damages. Flood forecasting warnings of up to eight to ten hours or more are possible for the lower Swatara Watershed providing sufficient time for substantial reductions in flood damages.

FIGURE 2

INVENTORY OF PUBLIC SERVICE AND SAFETY ORGANIZATIONS WITH POTENTIAL FOR OR ROLES RELATED TO FLOOD WARNING AND EVACUATION ACTIVITIES

Organization	Leader's Name	Address	Telephone Number
Civil Defense			
Firemen			
Police (Municipal)			
Sheriff			
State Police			
Highway Depts., Street Dept. (Municipal)			
County Highway Department			
State Highway Department			
Hospitals, Medical Clinics			
Ambulance Service (Public)			
Ambulance Service (Private)			
Civil Air Patrol			
HAM Radio Operators, Organization/Individual			
Red Cross			
National Guard			
Other (list)			

FIGURE 3

FLOOD ALERT ORGANIZATIONAL ASSESSMENT

Organization: ____________________

Name of Person Responsible: ____________________

Address: ____________________

____

Telephone: ____________________ (Home) ____________________ (Office)

Are you Appointed: ____________ Elected: ____________

Are you Full-time ____________ Part-time ____________

Do you receive compensation ________ or are you a volunteer ________

Please describe briefly what you think are (or could be) the major responsibilities of your organization during a flood emergency:

____

____

____

What manpower do you have available during an emergency (No. of people): ____________________

What transportation facilities, if any, do you have available during a flood emergency: No. of trucks ________ Buses ________

Cars ________ Other ________

What communication facilities do you have available during a flood emergency: Radios ________ Base Station ________

Mobile Units ________ Telephone ________ No. of telephone

lines ________ Other ________

Location Vulnerability: In case of severe storm or flooding, would your equipment, facilities, or offices be subject to damage or inaccessibility: ____________________

Do you have other responsibilities during an emergency: ____________

____

If you do, would they receive priority over the flood warning program: ____________________

FIGURE 5

SWATARA CREEK FLOOD WARNING GAGE SYSTEM

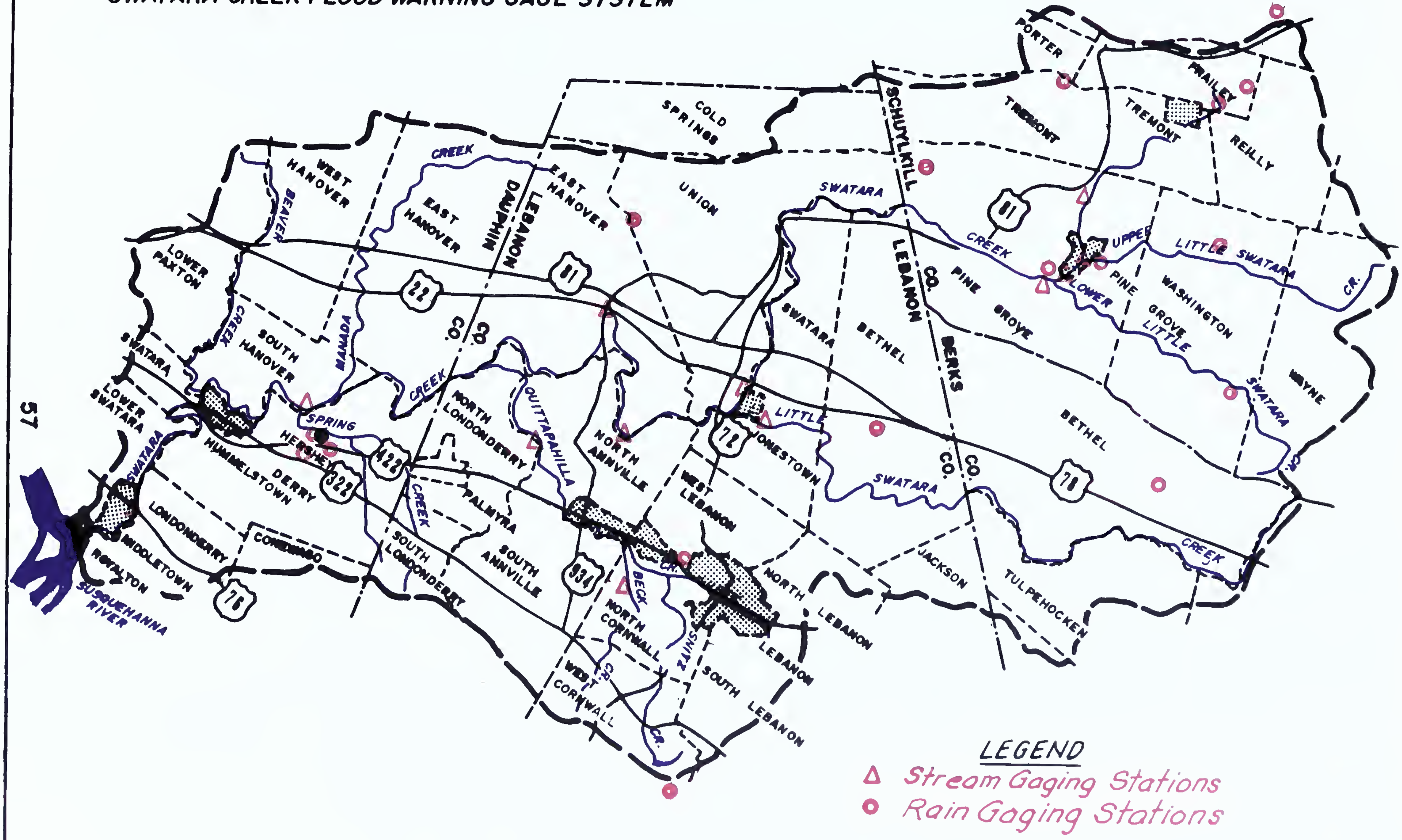
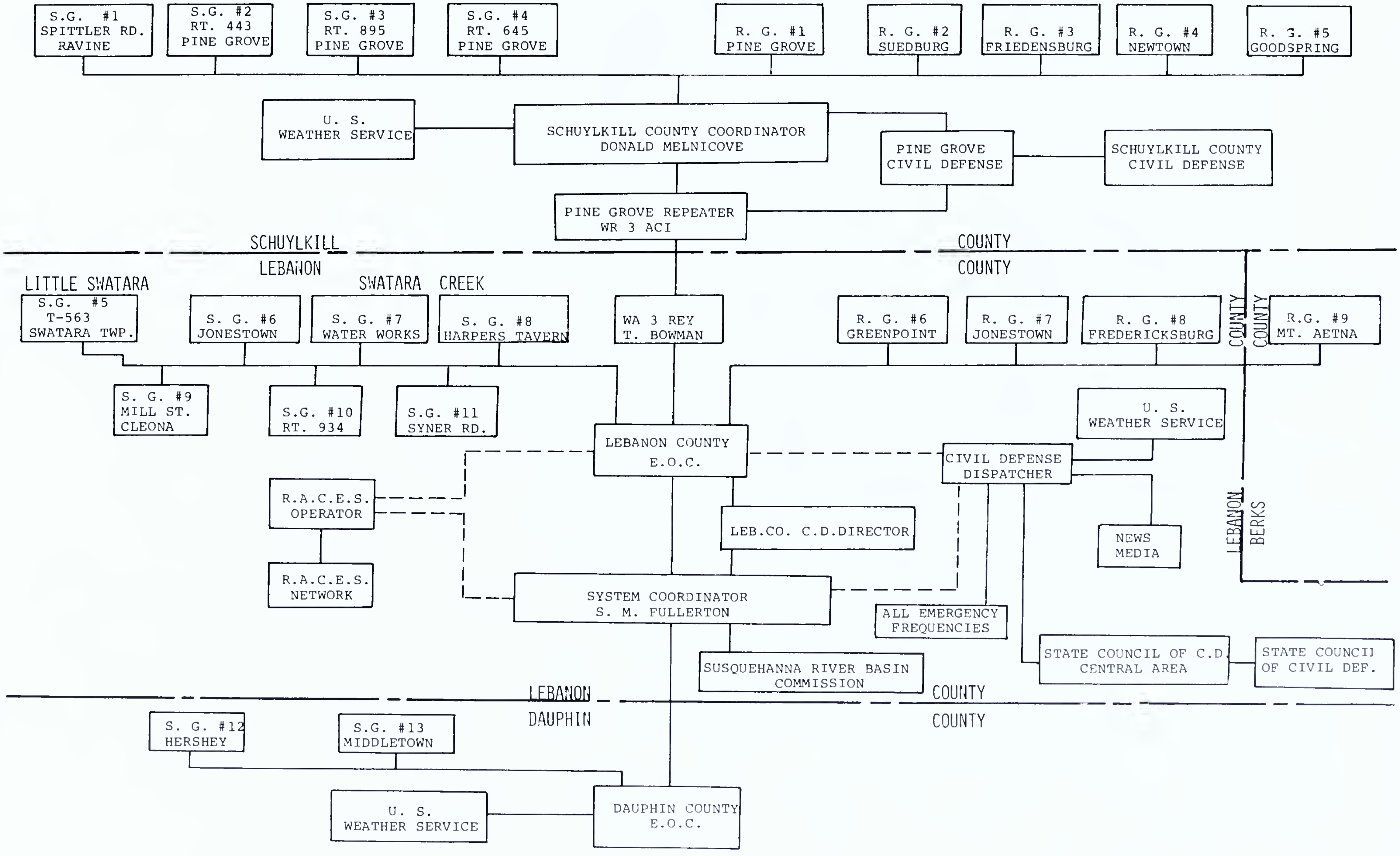


FIGURE 6

SWATARA WATERSHED

TRI COUNTY STREAM PREDICTION AND WARNING COMMUNICATION SYSTEM



-NOTES-

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